pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

NORTHWEST REGIONAL OFFICE **MEMO**

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DATE: January 10, 2013

RE: Aquatic Biology Investigation
Warren City Wastewater Treatment Plant (PA0027120)
Waste Treatment Corporation (PA0102784)
Allegheny River (Stream Code 42122)
City of Warren, Warren County

INTRODUCTION

On October 5, 2012, a Department Water Pollution Biologist from the Northwest Regional Office sampled benthic macroinvertebrates on the Allegheny River (SC 42122) in the vicinity of the Warren City Wastewater Treatment Plant (WWTP) and Waste Treatment Corporation (WTC) discharge outfall locations. On October 18, 2012, Department Water Pollution Biologists sampled sediment and water to be tested for radionuclides, organics (WTC effluent only), metals and additional general chemistry components.

The purpose of the aquatic biological investigation was to examine and determine if the WWTP and WTC discharges are having a negative impact on the Allegheny River. Benthic macroinvertebrates were collected at five locations on the Allegheny River to bracket the WWTP and WTC discharge locations. Sediment and water were collected at four of the five

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locations in addition to the effluent at the WTC outfall. The WWTP currently operates under NPDES permit number PA0027120. Effluent discharged from this facility includes treated municipal sewage. WTC currently operates under expired NPDES permit number PA0102784. Effluent discharged from this facility includes treated industrial waste produced by the oil and gas industry. The WTC NPDES permit has been expired since November 18, 2008. Both water pollution control facilities have discharge outfalls to the Allegheny River along the left descending bank. The outfall locations are approximately 60-meters apart with the WWTP outfall upstream of the WTC outfall.

Concurrently, the United States Fish and Wildlife Service (USFWS) and the United States Geological Survey (USGS) conducted independent studies using caged mussels and water quality monitoring in the vicinity of the WWTP and WTC outfalls. Their objective was to determine the concentrations (i.e. TDS, chloride, etc.) that can be safely discharged from these facilities to protect the federal and state endangered northern rifffleshell, *Epioblasma torulosa,* and clubshell, *Pleurobema clava*, mussels. Each mussel cage consisted of 20-30 juvenile clubshell mussels. Each location consisted of 5 cages. Cage locations were situated both upstream (reference) of both outfalls, within the discharge plumes of the WWTP and WTC outfalls and at three additional locations of varying distances downstream of the WTC outfall. Mussel cages were checked for acute toxicity at days 3 and 9, and then at multiple times over the remainder of the chronic (60 day) exposure period. Water chemistry data (both long-term monitoring field probes and grab samples) were collected at the same locations. The USFWS also contracted mussel surveys at locations on the Allegheny where transects have never been completed, including those in Warren both downstream and upstream of the WWTP and WTC outfalls. The USFWS and USGS will provide their findings in report form under separate cover.

GENERAL WATERSHED DESCRIPTION AND STATION LOCATIONS

The Allegheny River is designated and protected for Warmwater Fishes under 25 Pa. Code §93.9q. This section of the Allegheny River is currently attaining this aquatic life use designation. Station locations for benthic macroinvertebrate collections and sediment and water grab samples are tabulated in Table 1. Station 1ALR was considered a reference site and was located upstream of the WWTP and WTC outfalls (figure 1). Station 2ALR was located within an area 10-16 meters downstream of the WWTP discharge directly within the effluent plume. Station 3ALR (figure 2) was located within an area 50-56 meters downstream of the WWTP discharge and just upstream of the WTC discharge. Station 4ALR (figure 3) was located within an area 50-56 meters downstream of the WTC discharge. Station 5ALR (figure 4) was located downstream of the SR06 bridge and approximately 400 meters downstream of the WTC outfall location. Because of the width (i.e. approximately 130 meters across at the discharge locations) of the Allegheny River, all samples were collected along the left descending bank within the plume of the WWTP and WTC discharge locations.

SURVEY METHODS

Macroinvertebrates

Macroinvertebrates were collected, processed, and identified following the Instream Comprehensive Evaluation Protocol (Pennsylvania DEP, 2009). Sampling was standardized to riffles utilizing the best available habitat for each site. Six D-frame (500µm mesh netting) kicks, disturbing an area of one meter squared, were completed at each station. The six kicks were combined into a single jar and filled with 95% ethyl alcohol to preserve the macroinvertebrates. Upon arrival at the Department's lab, organisms were sub-sampled and identified to the lowest possible taxonomic level using a dissecting microscope. An Index of Biotic Integrity (IBI) was computed for each site using the sub-sampled macroinvertebrate assemblages. Benthic macroinvertebrate assemblages using specific metric analysis and an IBI score are a significant component in determining differences in aquatic communities and water quality between stations.

The ICE methodology employs using a 100-meter section of stream to collect the benthic macroinvertebrate sample. However, since the goal of this survey was to bracket the WWTP and WTC discharges, six concurrent 1-meter squared sections of substrate were disturbed for each benthic collection since adequate sampling habitat was not available between the WWTP and the WTC outfalls. Every effort was made to collect the benthic macroinvertebrates at each station equal distance from the left descending bank's shoreline (i.e. approximately 10 meters). Instream flow was correlated for each station, in addition to collecting within substrate ratios of similar cobble, gravel, sand, and silt. These ratios were approximately 50%/25%/20%/5%, respectively. For example, station 1ALR was sampled approximately 30-36 meters upstream of the WWTP and approximately within 10 meters of the left descending bank's shoreline in a mixture of cobble, gravel, sand, and silt with ratios of 50%/25%/20%/5%, respectively. The benthic macroinvertebrate sample was collected at station 2ALR from 16 to 10 meters downstream of the WWTP outfall and was directly within the plume of the discharge so that during low flow conditions little or no mixing with the Allegheny River was occurring. At station 3ALR, the benthic macroinvertebrate sample was collected from 56 to 50 meters downstream of the WWTP outfall with some mixing occurring with the Allegheny River. At station 4ALR, the benthic macroinvertebrate sample was collected from 56 to 50 meters downstream of the WTC outfall with some mixing occurring with the Allegheny River. At station 5ALR, the benthic macroinvertebrate sample was collected downstream of the SR06 Bridge and approximately 400 meters downstream of the WTC outfall with some mixing occurring with the Allegheny River. Conductivity measurements using an Oakton® handheld pH/conductivity/temperature meter was used to determine approximate mixing zones and sampling locations where the discharge plumes occurred.

Water Quality Sampling

Water samples were collected on October 18, 2012. The Department's Bureau of Laboratories (BOL) Standard Analysis Code (SAC) 046 was chosen for the analysis. A suite of twenty-seven (27) tests within SAC 046 were analyzed and included both inorganic parameters and metals. Water samples were collected at five stations and included benthic macroinvertebrate stations 1ALR, 3ALR, 4ALR, 5ALR, and at the WTC discharge.

Radionuclides were analyzed using the Department's BOL Suite RAD92 which includes two parameters; radium-228 and radium-226. Organic water samples were collected at the WTC discharge only using the Department's BOL Suite WSOL which includes the compounds triethylene glycol, diethylene glycol, methanol, ethanol, propylene glycol, 2-propenol, 1,2-ethanediol, and 2-butoxyethanol. Water samples were collected, preserved, shipped, and processed according to all Department methodologies for water sampling.

Sediment Sampling

Sediment samples were collected on October 18, 2012, at stations 1ALR, 3ALR, 4ALR, 5ALR, and the WTC discharge. The Department's BOL SAC 961 was chosen for the analysis. Thirteen (13) parameters within SAC 961 were analyzed for metals, chloride, and bromide. In addition, twenty-two isotopes within Suites RAD95 and RAD35 were analyzed. Instream sediments were collected, preserved, shipped and processed according to all Department methodologies for sediment sampling (DEP, 2012*draft*).

RESULTS AND DISCUSSION

Macroinvertebrates

Flow on the day of sampling was 1690 cubic feet per second (cfs) according to the USGS gaging station on the Allegheny River at Warren (USGS station number 03015310). Macroinvertebrate assemblages varied significantly between stations upstream and downstream of the WWTP and WTC discharge (Table 2). There were significant shifts in the macroinvertebrate community structure and dominant taxa between stations. Reference station 1ALR and stations 2ALR and 3ALR displayed an aquatic community typical of the upper Allegheny River. The aquatic community at station 1ALR was dominated by pollution-sensitive and pollution-facultative Ephemeroptera and Trichoptera along with aquatic Coleoptera in the family Elmidae, the gastropod, Valvatidae, and bivalves in the family Sphaeriidae. An aquatic community shift, however, existed as you moved downstream to stations 4ALR and 5ALR. These two stations lacked many of the Ephemeroptera, Trichoptera and Coleoptera found upstream and were replaced by the pollution-facultative group, *Caecidotea*, and a greater proportion of pollution-tolerant groups such as Chironomidae, Oligochaeta, and Turbellaria.
The following table illustrates the combined percentages of these four pollution-tolerant groups at each station:

Pollution-Tolerant Taxa in Sub-Sample	1ALR	2ALR	3ALR	4ALR	5ALR
Chironomidae	0	33	10	36	63
Oligochaeta	13	27	21	80	16
Turbellaria	2	11	5	8	44
Caecidotea	0	0	0	45	3
Total # Individuals in Sub-Sample	15	71	36	169	126
200-organism subsample Total	203	191	203	217	231
Percentage (%)	**7.4**	**37.2**	**17.6**	**77.9**	**54.5**

Two aquatic macroinvertebrate community similarity indices, the Community Loss Index and the Jaccard Coefficient, were used to compare station likeness. The Community Loss Index, developed by Courtemanch and Davies (1987), measures the loss of benthic taxa between a reference station and the station of comparison. Values can range from zero to "infinity." The Jaccard Coefficient (Plafkin et al. 1999) measures the degree of similarity in taxonomic composition between two stations in terms of taxon presence or absence. Coefficient values, ranging from 0 to 1.0, increase as the degree of similarity with the reference station increases. The following table summarizes the comparisons made between stations:

Community Similarity Indices		
Reference VS Comparison	**Community Loss Index**	**Jaccard Coefficient**
1ALR vs 2ALR	0.33	0.61
1ALR vs 3ALR	0.17	0.58
1ALR vs 4ALR	1.20	0.19
1ALR vs 5ALR	0.36	0.53
3ALR vs 4ALR	1.27	0.29
3ALR vs 5ALR	0.50	0.55

Both indices displayed similar characteristics when comparing stations. The two stations most dissimilar occurred when station 1ALR and 3ALR were directly compared to station 4ALR, indicating significant taxonomic differences between these stations.

The Department characterizes macroinvertebrate communities through an IBI score. This method is used to determine stream health and aquatic life attainment status of a waterbody (Karr 1980). The IBI is scored from 0-100, with a higher score indicating more pristine conditions and better water quality. IBIs are computed using a suite of metrics measuring characteristics of a macroinvertebrate community. Metrics used for the Department's Freestone IBI include taxa richness, EPT (Ephemeroptera, Plecoptera, and Trichoptera) richness, Beck's Index, Hilsenhoff Biotic Index, percentage of intolerant individuals, and the Shannon Diversity Index. In general, if a stream scores greater than 63.0, it is considered to be attaining its aquatic life designated use. Scores that range from 50 to 63 may or may not be considered impaired based on specific metric criteria. If the IBI score is less than 50, the stream is considered to be not attaining its designated aquatic life use. The six metrics are explained in more detail in the following text and summarized in Table 3. The large-stream metric standardization values were applied to calculate the IBI according to the Department's methodology.

Taxa richness is the overall number of taxa found within a sample. Generally, taxa richness will decrease with increasing anthropogenic stress, as pollution tolerant taxa dominate the macroinvertebrate assemblage and sensitive taxa are lost. Taxa richness was highest (29 taxa) at station 3ALR and lowest (15 taxa) at station 4ALR, a 48% decrease in taxonomic diversity directly downstream of the WTC discharge and a 24% decrease in richness at station 5ALR.

EPT richness is the number of mayfly, stonefly, and caddisfly taxa collected at each site. Collectively, these orders are regarded as the most sensitive aquatic macroinvertebrates.

This metric only includes the EPT taxa that have pollution tolerance values (PTV) (i.e. Hilsenhoff scores) of zero to four. EPT taxa richness typically decreases as anthropogenic stress increases due to the loss of pollution sensitive taxa from the benthic community. EPT richness decreased nearly 86% from the reference to an impacted station (i.e. 1ALR vs. 4ALR). A recovery in EPT richness at station 5ALR did occur. However, the number of EPT individuals was considerably lower.

Beck's Index is a weighted count of taxa with a pollution tolerance value of zero to two. This metric tends to decrease with increasing anthropogenic stress due to a replacement of sensitive taxa with more tolerant taxa. Beck's Index dropped 100% from the reference to an impacted station (1ALR vs. 4ALR). A 57% decrease in the Beck's Index was also calculated at station 5ALR.

The Hilsenhoff Biotic Index (HBI) measures organic pollution tolerance and was modified for organisms found in Pennsylvania (Hilsenhoff 1987, 1988). The HBI is the average pollution tolerance value of the macroinvertebrates collected in a sample. The index assigns a value to each taxonomic group. Values range from zero for organisms that are very intolerant of organic pollution to ten for organisms extremely tolerant of pollution. Typically, HBI scores increase as anthropogenic stressors increase due to the deficiency of pollution sensitive macroinvertebrates. An overall HBI score was calculated for the entire subsample. The HBI ranged from 4.88 at station 1ALR to 7.64 at station 4ALR. These scores are interpreted according to the following chart from Hilsenhoff:

Hilsenhoff Biotic Index Condition Scoring Criteria

Score	***Narrative Range***	***Degree of Organic Pollution***	***Station HBI Range***
0.00 - 3.50	Excellent	No apparent organic pollution	
3.51 - 4.50	Very Good	Possible slight organic pollution	
4.51 - 5.50	Good	Some organic pollution	1ALR, 2ALR, 3ALR
5.51 - 6.50	Fair	Fairly significant organic pollution	5ALR
6.51 - 7.50	Fairly Poor	Significant organic pollution	
7.51 - 8.50	Poor	Very significant organic pollution	4ALR
8.51- 10.00	Very Poor	Severe organic pollution	

From the following chart, the overall HBI score at stations 1ALR, 2ALR, and 3ALR were in the *good* narrative range, indicating some organic pollution. Overall HBI scores in this range are what would be expected in large warm water fisheries such as the Allegheny River. Station 4ALR had the highest HBI score and was in the *poor* range, indicating very significant organic pollution. Station 5ALR had an overall HBI score of 6.16, indicating fairly significant organic pollution.

The percent of pollution sensitive individuals is the percentage of macroinvertebrate organisms with pollution tolerance values of three or less. Generally, this value will decline as anthropogenic stress increases. Station 1ALR had the highest percentage of pollution intolerant individuals in the sub-sample (38.4%), followed by 2ALR (20.9%), and 3ALR (16.1%). Only 3.2% and 8.7% of the individuals collected at stations 4ALR and 5ALR are considered pollution sensitive.

The Shannon Diversity Index is a measure of the taxonomic richness and taxonomic evenness of macroinvertebrates at each site. This metric tends to decrease as anthropogenic stress increases due to the dominance of pollution tolerant taxa. Stations 4ALR and 5ALR had modest decreases in the Shannon Diversity Index compared to the reference station, 1ALR.

IBI scores differed significantly between station 1ALR and downstream stations. The reference station had an IBI score of 62.7. The IBI score at station 2ALR, just downstream of the WWTP discharge, was 49.6; a 13.1 point decrease from the upstream reference station. The IBI score at station 3ALR was slightly higher (i.e. 1.2 points) than station 1ALR. A significant decrease occurred at station 4ALR where the IBI score was 25.8 or 36.9 points lower than the reference station. A modest increase in the IBI score occurred at station 5ALR. However, this station still scored 17.2 points lower than the reference station. Stations 2ALR, 4ALR and 5ALR also scored below the aquatic life use (ALU) attainment threshold of 50. Station 3ALR scored just above the ALU attainment threshold while station 1ALR scored nearly at the threshold.

Water Quality Sampling

Water grab samples were collected at benthic macroinvertebrate stations 1ALR, 3ALR, 4ALR, and 5ALR, in addition to the WTC discharge. Results are summarized in Table 4. Station 1ALR was used as a background standard and compared to downstream stations. Station 3ALR was used as a background to compare stations 4ALR and 5ALR so that additions from the WWTP discharge were not additive when evaluating the WTC discharge effluent. The water clarity was subjectively categorized as clear at all stations and flow was 1,560 cfs according to the USGS gaging station on the Allegheny River at Warren (USGS station number 03015310)

Water sample results at station 1ALR indicate that excellent water quality exists in the upper portion of the Allegheny River. All parameters appear to be within normal limits and protective of aquatic life use. Water chemistry at station 3ALR was similar to background with the exception of slightly elevated phosphorus, nitrogen, ammonia and specific conductivity measurements. These observations can be attributed to the wastewater discharge plume directly upstream. All metal parameters tested were near background samples analyzed at station 1ALR.

Many of the parameters tested within the WTC discharge were high compared to background. Total phosphorus, nitrogen and ammonia along with the biochemical oxygen demand were elevated; indicating organic enrichment inputs to the receiving stream from the WTC discharge. Total dissolved solids (TDS), a measure of the amount of dissolved material such as sodium, chloride, and sulfate in the water column was 15,288 mg/l coming from the WTC discharge and was extremely elevated at stations 4ALR and 5ALR when compared to 3ALR. Specific conductivity, a measure of waters ionic activity and content and also a good measure of the concentration of total dissolved solids and salinity, was proportionally elevated with the TDS concentration. Hardness, generally due to the presence of elements such as calcium and magnesium in water, was 6,123 mg/L at the WTC discharge and 1,204 mg/L and 638 mg/L at downstream stations 4ALR and 5ALR, respectively. Hardness upstream of the WTC discharge was 74 mg/L. Several ions that

were tested such as chloride, bromide, and sulfate and metals, which included calcium, magnesium, sodium, barium, lithium, and strontium, were elevated downstream of the WTC discharge. Metals which were tested and were similar in concentration between upstream and downstream locations include aluminum, arsenic, boron, iron, manganese, selenium, and zinc. Additional parameters tested which were similar in concentration between stations include alkalinity, pH, and total suspended solids.

Osmotic pressure is a measure of the ability of an organism to regulate its internal salt and water balance. The Department's Chapter 93, Water Quality Standards (specifically §93.7, pertaining to specific water quality criteria and critical uses) states the measure of osmotic pressure in water shall not exceed 50 milliosomoles per kilogram to protect the designated Warmwater Fishery use on the Allegheny River. Station 4ALR and 5ALR had readings at or above this criterion, measuring 126 and 49, respectively. Measurements upstream of the WTC discharge at stations 1ALR and 3ALR were 2 and 19, respectively.

Organic compounds were collected in water and analyzed at the WTC discharge only. Of the seven parameters analyzed, six were below reporting limits. Methanol, which measured 1.5 mg/L, was the only organic compound that was detected.

Sediment Sampling

Sediment sampling results are summarized in Table 5. Sediment odors appeared normal at station 1ALR and no sediment oils were observed. In addition, there was no evidence of sewage odors in the sediment at stations 2ALR and 3ALR, downstream of the WWTP discharge. The WTC discharge sediment was black with a strong petroleum odor and petroleum oils were present. Station 4ALR and 5ALR had some petroleum related sediment odor and oil with black sediment occurring in depositional and erosional areas.

Metals and radionuclides were tested in sediment at stations 1ALR, 3ALR, 4ALR, 5ALR and the WTC discharge. Radionuclides were ingrown in the lab for 21 days and gamma results were read. Ingrowing samples allows the isotopes to reach equilibrium and therefore be read more accurately. Some radionuclides in the thorium and uranium decay series were elevated at the WTC discharge: lead-212 (8,550 pCi/kg +/- 575 pCi/kg); radium-226 (55,400 pCi/kg +/- 3,890 pCi/kg); lead-214 (41,100 pCi/kg +/- 2,650 pCi/kg); and radium-228 (24,300 pCi/kg +/- 1,920 pCi/kg). Barium, sodium, and strontium appeared notably elevated in the discharge sediment (3,076 mg/kg, 1,062 mg/kg, and 366 mg/kg, respectively). The remaining isotopes tested for were not detected, except for beryllium-7 and cesium-137. These were detected in low amounts, which are expected. Beryllium-7 is a cosmic radionuclide that is often found in surface deposits, and cesium-137 occurs due to radioactive fallout.

CONCLUSIONS

The purpose of the aquatic biological investigation was to examine and determine if the WWTP and WTC discharges are having a negative impact on the Allegheny River. The results of this study suggest the WTC discharge is negatively impacting the macroinvertebrate community of the receiving stream. To a much lesser extent, the WWTP

is having a slight impact on the Allegheny River. However, this impact is extremely minimal and contained to a swath of the receiving stream that is less than 50 meters downstream of the discharge and approximately 10 meters wide from the left descending bank.

Water chemistry from the WTC discharge is certainly affecting the biotic community downstream as evidenced by the benthic macroinvertebrate IBI scores and individual metrics analyzed. The six metrics used to calculate the IBI all exhibit a strong ability to distinguish between environmental perturbation and more pristine locations. When compiled into an IBI, these six metrics provide a solid foundation for assessing the biological condition of benthic macroinvertebrate assemblages at a particular site and overall stream health. The Department subjectively uses a precision estimate of eleven (11.0) points between IBI scores when comparing differences in the aquatic macroinvertebrate community of two stations. For instance, if the IBI score between a reference station (i.e. 1ALR) and a comparison station (i.e. 4ALR) is greater than 11 points, the comparison station is said to be impacted from some source and cause of anthropogenic stress. Comparing the five IBI scores computed at stations 1ALR, 2ALR, 3ALR, 4ALR, and 5ALR using station 1ALR as a reference station, it is apparent that station 4ALR is severely impacted (i.e. decrease of 36.9 points) and station 5ALR is at least moderately impacted (i.e. decrease of 17.2 points) from the WTC effluent entering the Allegheny River. A decrease in 13.1 points was calculated when comparing stations 1ALR to 2ALR. However, station 3ALR's IBI score increased 1.2 points over the reference station. This indicates a quick recovery downstream of the WWTP discharge.

Additional metrics included in Table 3 also show a decreased proportion of pollution-sensitive benthic taxa and an increased proportion of pollution-tolerant taxa downstream of the WTC discharge and to a lesser degree the WWTP discharge. The loss of two very important and sensitive taxonomic groups (i.e. the Ephemeroptera and Trichoptera) also illustrate that the biological community shifts as you go downstream from reference station 1ALR.

The IBI scores and the change in macroinvertebrate community structure at the two sites downstream of the WTC outfall indicate the discharge is negatively affecting the Allegheny River. The IBI score dropped significantly at station 4ALR and only modestly improved at station 5ALR. All six metrics used to calculate the Department's IBI had poorer scores downstream of the discharge. Most of these metric changes were substantial. Macroinvertebrate communities varied considerably and the number of sensitive taxa declined. Many of these sensitive taxa were replaced by pollution facultative or tolerant taxa. Differences among sites can be attributed to the WTC discharge, since no other factors were observed between the upstream and downstream stations.

This study did not determine or quantify the length of impairment emanating from the WTC discharge. The impact to the aquatic community in the Allegheny River, however, is certainly affected within a swath approximately covering 25% of the surface area from the left descending bank downstream to station 5ALR. However, it can be determined with reasonable certainty that the Allegheny River aquatic community improves as complete

mixing occurs with the receiving stream and the WTC discharge because of the large amount of flow in the Allegheny River. The degree of improvement and the evaluation of complete mixing were beyond the scope of this aquatic biology investigation.

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Table 1. Station Locations, Allegheny River, Warren County, Pennsylvania

Station	GIS Key Descriptor	GPS Coordinate Location	General Location Description
1ALR	20121005-1130-jbrancato	79°9'43.13"W 41°50'21.0"N	Allegheny River just upstream of the Warren WWTF discharge.
2ALR	20121005-1100-jbrancato	79°9'43.26"W 41°50'20.1"N	Allegheny River just downstream of the Warren WWTF discharge.
3ALR	20121005-1030-jbrancato	79°9'43.43"W 41°50'18.8"N	Allegheny River just upstream of the WTC discharge.
4ALR	20121005-1000-jbrancato	79°9'43.54"W 41°50'17.1"N	Allegheny River just downstream of the WTC discharge.
5ALR	21021005-1200-jbrancato	79°9'44.18"W 41°50'4.86"N	Allegheny River just downstream of the SR06 bridge.

Table 2. Benthic Macroinvertebrate Taxonomic Organisms Collected, Allegheny River, Warren County, Pennsylvania.

Benthic Macroinvertebrate Taxa		PTV	Stations				
			1ALR	2ALR	3ALR	4ALR	5ALR
EPHEMEROPTERA							
Baetidae	*Acentrella*	4	-	-	1	-	4
	Baetis	6	1	-	1	-	-
Ephemerellidae	*Serratella*	2	15	2	3	-	7
Ephemeridae	*Ephemera*	2	-	-	2	-	-
Heptageniidae	*MacCaffertium*	3	13	1	7	-	1
	Stenacron	4	-	2	12	-	-
Isonychidae	*Isonychia*	3	29	1	4	-	1
Potamanthidae	*Anthopotamus*	4	-	-	1	-	-
PLECOPTERA							
Perlidae	*Acroneuria*	0	1	-	-	-	-
TRICHOPTERA							
Brachycentridae	*Brachycentrus*	1	2	1	1	-	8
Glossosomatidae	*Protoptila*	1	-	-	2	-	-
Helicopsychidae	*Helicopsyche*	3	-	-	1	1	-
Hydropsychidae	*Ceratopsyche*	5	11	1	-	-	-
	Cheumatopsyche	6	12	3	5	-	4
	Hydropsyche	5	-	-	4	-	17
	Macrostemum	3	4	-	-	-	-
Philopotamidae	*Chimarra*	4	6	-	1	-	5
Polycentropodidae	*Polycentropus*	6	-	-	2	1	-
MEGALOPTERA							
Corydalidae	*Corydalus*	4	2	-	-	-	1
LEPIDOPTERA							
Pyralidae	*Petrophila*	5	1	4	-	-	1
AQUATIC COLEOPTERA							
Elmidae	*Optioservus*	4	26	25	37	1	19
	Oulimnius	5	2	1	1	-	-
	Stenelmis	5	2	24	30	-	4
Psephenidae	*Ectopria*	5	-	1	-	-	-
	Psephenus	4	4	11	8	-	-
AQUATIC DIPTERA							
Chironomidae		6	-	33	10	36	63
Empididae	*Hemerodromia*	6	-	-	6	3	8
Simulidae	*Simulium*	6	-	-	-	1	19
Tipulidae	*Antocha*	3	1	3	3	6	3

Table 2. Benthic Macroinvertebrate Taxonomic Organisms Collected *(continued)*.

Benthic Macroinvertebrate Taxa		PTV	Stations				
			1ALR	2ALR	3ALR	4ALR	5ALR
Non-Insect Taxa							
Oligochaeta		10	13	27	21	80	16
Turbellaria		9	2	11	5	8	44
Hirundinea		8	-	1	-	1	-
Hydracarina		7	2	-	1	-	1
ODONATA							
Coenagrionidae	*Argia*	6	-	-	-	1	-
GASTROPODA / BIVALVIA							
Sphaeriidae		8	36	-	14	1	1
Ancylidae		7	4	6	11	31	1
Valvatidae		2	13	32	10	-	-
Planorbidae		6	-	-	-	1	-
AMPHIPODA							
Crangonictidae	*Crangonyx*	4	1	1	1	-	-
ISOPODA							
Asellidae	*Caecidotea*	6	-	-	-	45	3
Taxonomic Richness			24	21	29	15	22

Table 3. Metric Analysis for benthic macroinvertebrate stations, Allegheny River, Warren County, Pennsylvania.

Metric Analysis	Stations				
	1ALR	2ALR	3ALR	4ALR	5ALR
Metrics used to compute the IBI					
Taxonomic Richness	24	21	29	15	22
Modified EPT Richness	7	5	11	1	6
Becks Index	7	4	7	0	3
Modified Hilsenhoff Biotic Index	4.88	5.39	5.33	7.64	6.16
% Intolerant Individuals	38.4	20.9	16.1	3.2	8.7
Shannon Diversity	2.63	2.37	2.80	1.75	2.37
Index Biological Integrity (IBI) Score	**62.7**	**49.6**	**63.9**	**25.8**	**45.5**
IBI difference from reference station 1ALR	**Reference**	**-13.1**	**+1.2**	**-36.9**	**-17.2**
Additional Metrics					
% Ephemeroptera	28.6	3.1	15.1	0.0	5.6
% Trichoptera	17.2	2.6	7.8	0.9	14.7
% Dominant Taxon	17.7	17.3	18.1	36.9	27.3
% Pollution Intolerant Individuals (PTV 0-3)	38.4	20.9	16.1	3.2	8.7
% Pollution Intolerant Individuals (PTV 0-5)	65.5	57.6	62.9	3.7	30.7
% Pollution Tolerant Individuals (PTV 7-10)	28.1	23.6	25.4	55.8	27.3

Table 4. Water Chemistry Sampling Results, Allegheny River, Warren County, Pennsylvania.

Water Chemistry Results		Stations				
		1ALR	3ALR	WTC discharge	4ALR	5ALR
Parameter	Units	DEP Bureau of Labs Standard Analysis Code 046				
pH (units)	units	7.8	7.8	7.3	7.6	7.6
Alkalinity T as CACO3	mg/L	55.4	71.6	68.6	66.4	56.4
Phosphorus T	mg/L	0.032	0.735	0.732	0.670	0.226
Nitrogen T (NO3 + NO2)	mg/L	0.41	2.59	2.41	1.68	0.90
Ammonia-N T	mg/L	0.06	2.00	12.88	3.50	1.27
Biological Oxygen Demand (BOD5)	mg/L	0.70	1.00	15.30	5.30	2.40
Hardness T	mg/L	62	74	6123	1204	638
Specific Conductivity (@25˚C)	µS/cm	198	368	29700	8460	3530
Total Dissolved Solids (TDS)	mg/L	112	104	15288	5926	2712
Osmotic Pressure	mOsm	2	19	368	126	49
Total Suspended Solids	mg/L	<5	<5	<5	<5	<5
Chloride by IC	mg/L	20.4	45.1	8080	2725	1065
Sulfate by IC	mg/L	10.6	15.9	66.8	28.4	19.2
Bromide T	ug/L	44	67	83438	27924	10489
Calcium T	mg/L	19	22	2080	399	213
Magnesium T	mg/L	4	4	224	50	26
Sodium T	mg/L	12	29	3970	798	396
Aluminum T	ug/L	<200	<200	<200	<200	<200
Arsenic T	ug/L	<3	<3	<30	3	<3
Barium T	ug/L	51	46	991	260	150
Boron T	ug/L	<200	<200	620	<200	<200
Iron T	ug/L	168	114	217	193	117
Lithium T	ug/L	<25	<25	3359	661	314
Manganese T	ug/L	70	56	78	69	52
Selenium T	ug/L	<7	<7	<70	<7	<7
Strontium T	ug/L	50	64	42000	8000	3967
Zinc T	ug/L	<10	22	10	<10	<10
Parameter	Units	DEP Bureau of Labs Suite RAD92				
Radium 226	pCi/L	0.0941 +/- 0.029	0.165 +/- 0.054	8.864 +/- 0.242	5.541+/- 0.196	1.518 +/- 0.096
Radium 228	pCi/L	0.218 +/- 0.512	0.467 +/- 0.557	16.305 +/- 1.289	5.522+/- 0.869	2.768 +/- 0.75
Parameter	Units	DEP Bureau of Labs Suite WSOL (organics)				
Triethylene glycol	mg/L	N/A	N/A	<5.0	N/A	N/A
Diethylene glycol	mg/L	N/A	N/A	<5.0	N/A	N/A
Methanol	mg/L	N/A	N/A	1.5	N/A	N/A
Propylene glycol	mg/L	N/A	N/A	<5.0	N/A	N/A
2-propanol	mg/L	N/A	N/A	<1.0	N/A	N/A
1,2-ethanediol	mg/L	N/A	N/A	<5.0	N/A	N/A
2-butoxyethanol	mg/L	N/A	N/A	<2.0	N/A	N/A

Table 5. Sediment Sampling Results, Allegheny River, Warren County, Pennsylvania.

Sediment Sampling Results		Stations				
		1ALR	3ALR	WTC discharge	4ALR	5ALR
Parameter	Units	DEP Bureau of Labs Suites RAD95 and RAD35				
Americium 241	pCi/kg	0	0	0	0	0
Barium 140	pCi/kg	0	0	0	0	0
Beryllium 7	pCi/kg	211 +/- 30	373 +/- 42	0	80 +/- 29	95 +/- 68
Cesium 134	pCi/kg	0	0	0	0	0
Cesium 137	pCi/kg	16 +/- 2	10 +/- 2	0	9 +/- 2	0
Cobalt 58	pCi/kg	0	0	0	0	0
Cobalt 60	pCi/kg	0	0	0	0	0
Iodine 131	pCi/kg	0	0	0	0	0
Iron 59	pCi/kg	0	0	0	0	0
Lanthanum 140	pCi/kg	0	0	0	0	0
Lead 214	pCi/kg	255 +/- 18	394 +/- 26	41,100 +/- 2,650	709 +/- 46	317 +/- 27
Lead 212	pCi/kg	282 +/- 20	387 +/- 25	8,550 +/- 575	477 +/- 31	267 +/- 20
Manganese 54	pCi/kg	0	0	0	0	0
Niobium 95	pCi/kg	0	0	0	0	0
Radium 228G	pCi/kg	289 +/- 25	371 +/- 31	24,300 +/- 1,920	642 +/- 47	307 +/- 35
Radium 226G	pCi/kg	576 +/- 60	827 +/- 91	55,400 +/- 3,890	1,310 +/- 115	758 +/- 134
Ruthenium 103	pCi/kg	0	0	0	0	0
Ruthenium 106	pCi/kg	0	0	0	0	0
Uranium 238	pCi/kg	0	0	0	0	0
Uranium 235	pCi/kg	0	0	0	0	0
Zinc 65	pCi/kg	0	0	0	0	0
Zirconium 95	pCi/kg	0	0	0	0	0
Parameter	Units	DEP Bureau of Labs Standard Analysis Code 961				
Uranium	mg/kg	<5.87	<5.78	<5.79	<4.49	<5.17
Chloride	mg/kg	<13.1	14	25	17	289
Magnesium	mg/kg	634	1130	611	675	1134
Sodium	mg/kg	<58.7	<57.8	1062	59	223
Iron	mg/kg	10571	12370	11996	10390	10911
Manganese	mg/kg	415	572	110	241	146
Nickel	mg/kg	9	9	10	7	9
Aluminum	mg/kg	2705	3264	1861	2140	3272
Barium	mg/kg	46.4	55.1	3076	87.2	53.4
Zinc	mg/kg	44.7	122	51.3	45.8	59.2
Strontium	mg/kg	4	9	366	12	17
Bromide	mg/kg	<5.26	<5.08	<5.37	<4.88	<5.29
Cadmium	mg/kg	<0.587	<0.578	<0.579	<0.449	<0.517

Figure 1. Allegheny River at the WWTP outfall location looking upstream at benthic macroinvertebrate sampling stations 1ALR and 2ALR, Warren County, Pennsylvania.

Figure 2. Allegheny River looking upstream at benthic macroinvertebrate sampling stations 3ALR and both the WWTP and WTC outfall locations, Warren County, Pennsylvania.

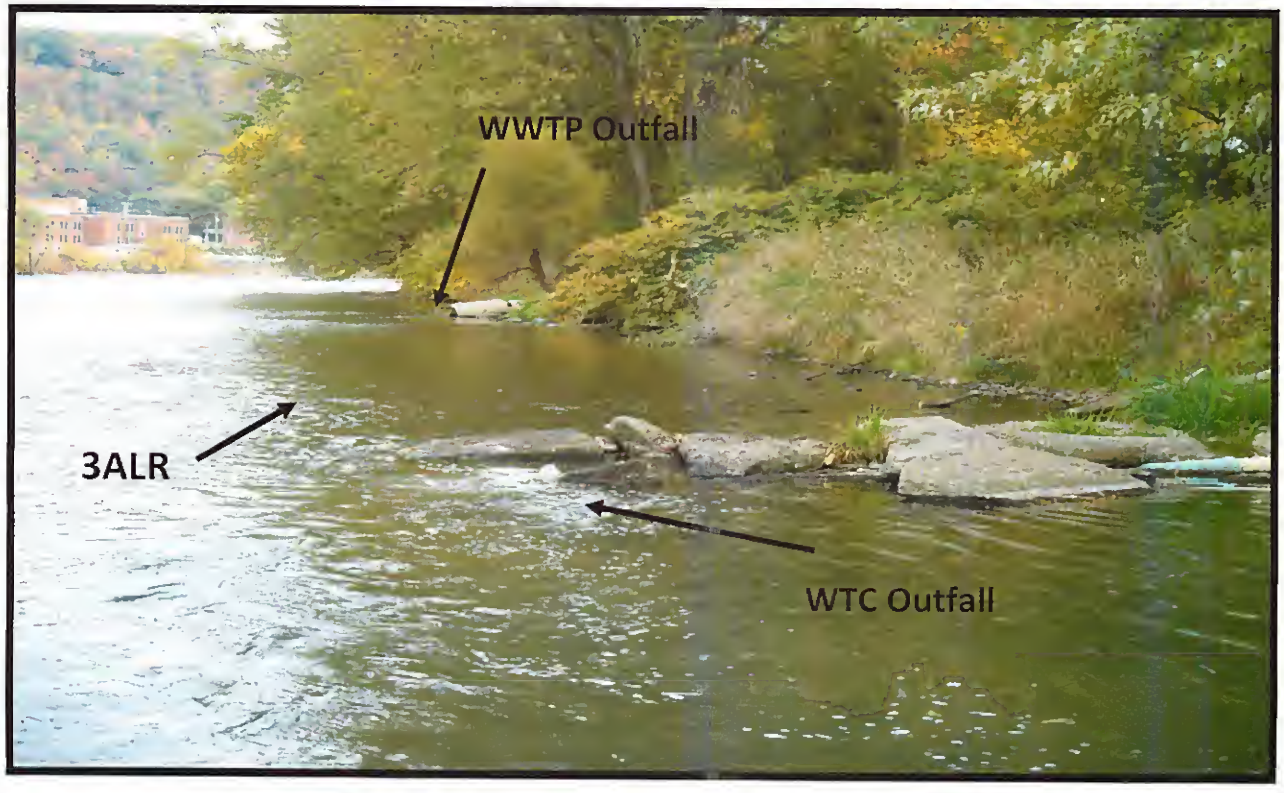

Figure 3. Allegheny River looking upstream at benthic macroinvertebrate sampling station 4ALR and both the WWTP and WTC outfall locations, Warren County, Pennsylvania.

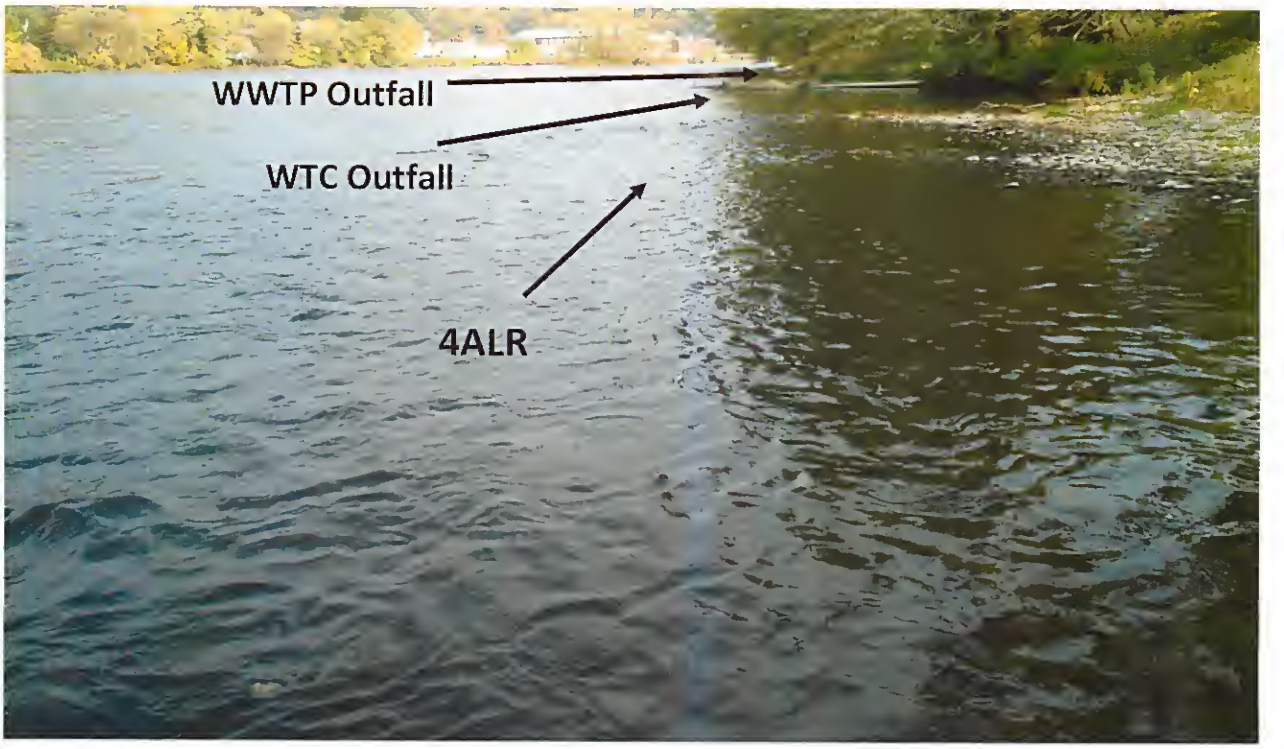

Figure 4. Allegheny River looking upstream at benthic macroinvertebrate sampling stations 5ALR , Warren County, Pennsylvania.

PROGRAM CW CONF. Y/N MICROFICHE Y/N

FILE NAME Allegheny River

BREAKDOWN Streams

TYPE Streams

COUNTY _____ MUNICIPALITY _____

COMMENTS Stream Code 42122